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THE INFLUENCE OF SOIL TILLAGE SYSTEMS AND WEED CONTROL METHODS ON WEED INFESTATION OF POTATO (*Solanum tuberosum* L.)

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Abstract

A field experiment was conducted in the years 2002-2004 at the Zawady Agricultural Experimental Station (52º06' N; 22º06' E), belonging to the University of Podlasie in Siedlce, Poland. The investigated factors were two soil tillage systems (traditional and reduced) and seven methods of weed control in potato canopies with herbicide application. The aim of the study was to determine the influence of tillage systems and weed control methods on the weed species composition and weed density. Tillage systems, weed control methods and atmospheric conditions prevailing in the study years significantly varied weed infestation of potato canopies at the beginning of vegetation and before tuber harvest. The lowest number of weeds, compared to the control treatment, was recorded in the treatments in which chemical and mechanical weed control had been applied. The treatments with the traditional tillage system also showed lower weed infestation than those in which simplifications had been applied.

Key words: potato, soil tillage system, weed, herbicide, weed control method

INTRODUCTION

Potato occupies, and will occupy, an important position in the crop structure, both in Polish and world agriculture (Dzienia and Boligłowa, 1997). The possibilities of potato processing development and an expected increase in consumption of potato products are the reasons why this plant will maintain its significant role in the next years (Zarzecka and Wyszyński, 2006). At the turn of the 20th and 21st centuries, substantial changes are made in the production of this plant and new technologies are sought, with varied frequency and intensity of tillage treatments or with complete abandonment of soil tillage (Arshad and Gill, 1996; Ball et al. 1994; Lopez-Bellido et al. 2000). The introduction of simplified tillage technologies is the cause of increased weed infestation (Mrówczyński et al. 2005; Rola and Rola, 1996; Sekutowski and Rola, 2006). In the opinion of Małecka and Blecharczyk (2000) as well as Radecki and Opic (1995), tillage simplifications promote weed emergence and development in plant crops (actual weed infestation) and the weed seed bank in the soil (potential weed infestation). Heller and Adamczewski (2002) found that in reduced tillage perennial weeds, annual grasses, self-sown crops and weeds whose seeds are transported by the wind are predominant; but the proportion of annual dicotyledonous weeds decreases.

Weed infestation of potato plantations forces the need to apply different weed control methods (Pytlarz-Kozicka, 2002). In the opinion of Gruczek (2001, 2004) and Zarzecka (2005), the negative effects of the introduction of tillage simplifications can be reduced through an appropriate selection and proper application of herbicides.

The aim of the study was to determine the influence of two soil tillage systems and weed control treatments with the application of herbicides and their mixtures on the weed species composition and weed density at the beginning of vegetation of the crop plant and before potato tuber harvest.

MATERIALS AND METHODS

A field experiment was conducted at the Zawady Agricultural Experimental Station on soil classified in the division – autogenic soils, order – brown soils, type – grey-brown podzolic soils formed from light loamy sands and strong loamy sands, soil quality class

IVa and IVb classified as very good rye complex. This soil was characterised by a slightly acid pH. The experiment was set up according to the split-splot design in three replications.

The experimental factors were as follows:

I. Soil tillage systems:

1. traditional (classic) tillage – post-harvest treatments (skimming and harrowing twice), in autumn inversion ploughing, pre-winter ploughing, and in spring – harrowing, cultivating and harrowing,
2. reduced tillage – post-harvest treatments (skimming and harrowing twice), in autumn inversion ploughing, and in spring cultivating.

II. Seven weed control methods:

1. control treatment – mechanical weed control until and after emergence of potato plants,
2. mechanical weed control until emergence, and right before emergence the application of the herbicide Plateen 41.5 WG at a dose of 2.0 kg × ha^{-1},
3. mechanical weed control until emergence, and right before emergence spraying with a mixture of herbicides Plateen 41.5 WG 2.0 kg × ha^{-1} + graminicide Fusilade Forte 150 EC – 2.5 dm^3 × ha^{-1},
4. mechanical weed control until emergence, and right before emergence spraying with a mixture of herbicides Plateen 41.5 WG – 1.6 kg × ha^{-1} + graminicide Fusilade Forte 150 EC 2.0 dm^3 × ha^{-1} + adjuvant Atpolan 80 EC 1.5 dm^3 × ha^{-1} (herbicide doses smaller by 20% compared to treatment 3),
5. mechanical weed control until emergence, and after emergence, when potatoes are 10-15 cm high, spraying with the herbicide Barox 460 SL – 3.0 dm^3 × ha^{-1},
6. mechanical weed control until emergence, and after emergence, when potatoes are 10-15 cm high, spraying with a mixture of herbicides Barox 460 SL – 3.0 dm^3 × ha^{-1} + graminicide Fusilade Forte 150 EC – 2.5 dm^3× ha^{-1},
7. mechanical weed control until emergence, and after emergence, when potatoes are 10-15 cm high, spraying with a mixture of herbicides Barox 460 SL – 2.4 dm^3 × ha^{-1} + graminicide Fusilade Forte 150 EC – 2.0 dm^3× ha^{-1} + adjuvant Atpolan 80 EC 1.5 dm^3 × ha^{-1} (herbicide doses smaller by 20% compared to treatment 6).

In the experiment, a medium-early edible variety of potato, Wiking, was grown. Potato was grown on plots after cereals. Each year in autumn, organic fertilization was applied in the form of manure at a dose of 25 t ha^{-1} as well as mineral fertilization: phosphorus and potassium fertilizers in the amount of P-32.86 kg × ha^{-1} and K-112.10 kg × ha^{-1}. In spring, before planting tubers, nitrogen fertilizers were applied at a dose of N 90 kg × ha^{-1}.

The analysis of weed infestation was performed at two dates: 2-3 weeks after herbicide application (before row closure) and at the end of potato vegetation (1-2 weeks before tuber harvest). The species composition and number of weeds were determined on test areas marked out by a frame (33.4 x 150 cm = 5010 cm^2) thrown randomly in three places on each plot, obliquely to the ridges. Weed infestation was calculated per 1 m^2. The weed infestation level was determined based on the following evaluation scale (W a l c z a k et al. 2000): 1 – marginal weed infestation (1 pc./m^{-2}), 2- low (2-9 pcs./m^{-2}), 3- medium (10-30 pcs./m^{-2}), 4- high (31-50 pcs./m^{-2}), 5- very high (>50 pcs./m^{-2}). Weed names followed M i r e k et al. (1995).

The results of the study were statistically analysed using analysis of variance. The significance of variability sources was tested by means of Fischer-Snedecor's F-test, and evaluation of the significance of differences at a significance level of $p = 0.05$ between comparable means was performed using Tukey's multiple range test.

The pattern of weather conditions in the study years was varied (Tab. 1). The year 2002 was a warm year with a quite favourable distribution of temperatures and different rainfall rates, with total rainfall lower than the long-term means. That year was marked by the absence of a dry spell, whereas the 2003 growing season was characterised by a severe dry spell. In all growing months, rainfall deficiency was observed compared to the long-term period and the highest rainfall deficiency occurred in June and August. When analysing the pattern of weather conditions in 2004, it was found out that that year was marked by the absence of a dry spell, but rainfall was distributed unevenly throughout particular growing months. Mean air temperature in the period in question was similar to the long-term mean.

STUDY RESULTS

The analysis of weed infestation performed before the closure of potato rows and before tuber harvest showed that the number of weeds per 1 m^2 was significantly dependent on soil tillage systems (Tab. 2). Significantly lower weed infestation at both dates was found in the treatments in which traditional tillage had been done, compared to the treatments in which reduced tillage had been applied. The average number of weeds per 1 m^2 was, respectively: before row closure (10.2 and 13.3) and before tuber harvest (10.2 and 12.8). Weed infestation in these treatments was at an average level.

Both before the closure of potato rows and prior to tuber harvest, weed species belonging to the dicotyledonous class were predominant over monocotyledonous

Table 1
Rainfall and air temperature in the growing seasons of 2002-2004 according to the Zawady Meteorological Station.

Years	Months						Total
	IV	V	VI	VII	VIII	IX	
			Rainfall, mm				
2002	12.9	51.3	61.1	99.6	66.5	18.7	310.1
2003	13.6	37.2	26.6	26.1	4.7	24.3	132.5
2004	35.9	97.0	52.8	49.0	66.7	19.5	320.9
Mean for 1981-1995	52.3	50.0	68.2	45.7	66.8	60.7	343.7
			Air temperature, °C			Mean	
2002	9.0	17.0	17.2	21.0	20.2	12.9	16.2
2003	7.1	15.6	18.4	20.0	18.4	13.5	15.5
2004	8.0	11.7	15.5	17.5	18.9	13.0	14.1
Mean for 1981-1995	7.7	10.0	16.1	19.3	18.0	13.0	14.0
			Sielianinov's hydrothermic coefficient*				
2002	1.5	1.0	1.2	1.5	2.1	1.5	1.1
2003	0.6	0.8	0.5	0.4	0.1	0.6	0.4
2004	1.5	2.7	1.1	0.9	1.1	0.5	1.2

* < 0.5 severe dry spell, 0.51-0.69 dry spell, 0.70-0.99 mild dry spell, ≥ 1 no dry spell

Table 2
The species composition and number of weeds per 1 m^2 depending the on soil tillage system.

Species	Soil tillage systems		Mean	Soil tillage systems		Mean
	traditional	reduced		traditional	reduced	
Before row closure				Before tuber harvest		
Fallopia convolvulus (L.)	0.9	1.1	1.0	0.9	1.1	1.0
Veronica arvensis (L.)	0.8	1.6	1.2	0.3	0.2	0.3
Capsella bursa–pastoris	0.7	1.3	1.0	0.1	0.1	0.1
Chenopodium album (L.)	0.6	1.0	0.8	1.0	1.6	1.3
Lamium purpureum (L.)	0.6	1.0	0.8	0.7	0.9	0.8
Sinapis arvensis (L.)	0.5	0.5	0.5	0.2	0.1	0.1
Polygonum persicaria (L.)	0.5	0.7	0.6	0.1	0.3	0.2
Galium aparine (L.)	0.4	0.2	0.3	–	–	–
Viola arvensis Murray	0.4	0.4	0.4	0.3	0.5	0.4
Plantago lanceolata (L.)	0.4	0.4	0.4	1.0	1.0	1.0
Convolvulus arvensis (L.)	0.3	0.5	0.4	0.3	0.3	0.3
Galinsoga parviflora Cav.	0.2	0.2	0.2	–	–	–
Stellaria media (L.)	0.1	0.3	0.2	1.4	1.8	1.6
Amaranthus retroflexus (L.)	0.1	0.2	0.1	0.2	0.2	0.2
Other species dicotyledonous 2002–2004 (3)*	1.2	1.2	1.2	0.9	1.3	1.1
Total of dicotyledonous	7.7	10.6	9.1	7.4	9.4	8.4
Elymus repens (L.)	1.8	1.8	1.8	1.8	1.9	1.9
Poa annua (L.)	0.4	0.6	0.5	0.6	0.9	0.7
Echinochloa crus–galli (L.)	0.3	0.3	0.3	0.4	0.6	0.5
Total monocotyledonous	2.5	2.7	2.6	2.8	3.4	3.1
Total dicotyledonous and monocotyledonous	10.2	13.3	11.7	10.2	12.8	11.5
$LSD_{0.05}$ between soil tillage systems			2.3	$LSD_{0.05}$ between soil tillage systems		2.1

***Urtica urens* (L.), *Thlaspi arvense* (L.), *Chamomilla suaveolens* (Pursh)

Table 3
The species composition and number of weeds per 1 m[2] before potato row closure depending on weed control methods.

Species	Weed control methods							Mean
	1*	2	3	4	5	6	7	
Fallopia convolvulus (L.)	1.3	1.1	1.8	1.0	0.5	0.3	0.9	1.0
Veronica arvensis (L.)	2.2	0.9	0.4	0.3	1.9	2.2	0.2	1.2
Capsella bursa–pastoris	2.2	0.9	0.4	0.3	1.9	2.2	0.2	1.2
Chenopodium album (L.)	1.8	0.6	1.0	0.3	0.8	0.7	0.6	0.8
Lamium purpureum (L.)	1.5	0.7	0.3	0.8	0.7	0.8	1.0	0.8
Sinapis arvensis (L.)	1.2	0.1	0.3	0.3	0.6	0.5	0.6	0.5
Polygonum persicaria (L.)	0.4	0.7	0.2	0.4	0.3	2.1	0.4	0.6
Galium aparine (L.)	0.3	0.2	0.2	0.2	–	–	1.2	0.3
Viola arvensis Murray	0.7	0.5	0.4	0.3	0.4	0.2	0.2	0.4
Plantago lanceolata (L.)	0.7	0.2	–	0.1	1.2	0.3	0.2	0.4
Convolvulus arvensis (L.)	0.7	0.3	–	0.1	0.5	0.7	0.6	0.4
Galinsoga parviflora Cav.	0.4	–	–	–	0.5	0.5	–	0.2
Stellaria media (L.)	0.4	–	0.4	0.2	–	0.4	–	0.2
Amaranthus retroflexus (L.)	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.2
Other dicotyledonous species 2002–2004 (3)*	3.1	0.9	0.9	0.7	0.8	0.9	0.8	1.2
Total dicotyledonous	17.7	6.7	6.8	5.3	9.3	9.8	8.5	9.1
Elumus repens (L.)	2.5	2.8	1.8	2.2	2.2	0.6	0.5	1.8
Poa annua (L.)	1.0	0.3	0.4	0.3	0.6	0.3	0.3	0.5
Echinochloa crus–galli (L.)	0.5	0.2	0.3	0.3	0.4	0.4	0.1	0.3
Total monocotyledonous	4.0	3.3	2.5	2.8	3.2	1.3	0.9	2.6
Total dicotyledonous and monocotyledonous	21.7	10.0	9.3	8.1	12.5	11.1	9.4	11.7
$LSD_{0.05}$ between weed control methods								3.8

* weed control methods as in research methodology
** *Urtica urens* (L.), *Thlaspi arvense* (L.), *Chamomilla suaveolens* (Pursh)

Table 4
The species composition and number of weeds per 1 m² before potato tuber harvest depending on weed control methods.

Species	Weed control methods							Mean
	1*	2	3	4	5	6	7	
Fallopia convolvulus (L.)	2.2	0.8	1.6	0.5	0.6	0.5	0.7	1.0
Veronica arvensis (L.)	0.8	0.1	0.1	0.1	0.4	0.2	0.2	0.3
Capsella bursa–pastoris	0.3	–	0.2	0.1	–	0.2	–	0.1
Chenopodium album (L.)	1.8	1.2	0.8	0.8	1.7	1.6	1.4	1.3
Lamium purpureum (L.)	0.8	0.9	0.3	0.6	1.0	1.0	0.9	0.8
Sinapis arvensis (L.)	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Polygonum persicaria (L.)	0.6	0.1	0.5	–	0.1	–	0.1	0.2
Galium aparine (L.)	–	0.1	–	0.1	–	0.1	–	–
Viola arvensis Murray	0.3	0.6	0.2	0.3	0.2	0.6	0.6	0.4
Plantago lanceolata (L.)	0.8	1.0	0.8	0.5	1.4	1.1	1.2	1.0
Convolvulus arvensis (L.)	0.4	0.4	0.3	0.4	0.2	0.4	0.2	0.3
Galinsoga parviflora Cav.	0.1	0.2	–	–	–	–	–	–
Stellaria media (L.)	3.1	1.5	1.8	1.4	0.7	1.6	0.9	1.6
Amaranthus retroflexus (L.)	0.8	0.1	–	0.1	0.1	0.3	0.1	0.2
Other dicotyledonous species 2002–2004 (3)**	1.4	0.8	0.8	1.0	1.2	0.9	1.4	1.1
Total dicotyledonous	13.6	7.9	7.5	6.0	7.7	8.6	7.9	8.4
Elymus repens (L.)	3.5	2.7	1.7	1.5	2.3	0.6	0.9	1.9
Echinochloa crus–galli (L.)	0.5	0.6	0.4	0.3	0.7	0.7	0.4	0.5
Poa annua (L.)	0.4	0.4	0.2	0.2	1.2	1.5	1.0	0.7
Total monocotyledonous	4.4	3.7	2.3	2.0	4.2	2.8	2.3	3.1
Total dicotyledonous and monocotyledonous	18.0	11.6	9.8	8.0	11.9	11.4	10.2	11.5
$LSD_{0.05}$ between weed control methods								2.9

* weed control methods as in research methodology

** *Urtica urens* (L.), *Thlaspi arvense* (L.), *Chamomilla suaveolens* (Pursh)

weeds (Tabs 2-6). Among dicotyledonous species, the following dominated at the beginning of vegetation: *Veronica arvensis* (L.), *Fallopia convolvulus* (L.), *Capsella bursa-pastoris* (L.), *Chenopodium album* (L.). The monocotyledonous class was represented by three species, among which *Elymus repens* (L.) dominated (Tabs 2, 3). At the end of vegetation of potato, species belonging to the dicotyledonous class also predominated over monocotyledonous weeds (Tabs 2, 4). Among monocotyledonous species, *Elymus repens* (L.) was predominant, likewise at the beginning of vegetation.

In the initial period of potato vegetation, i.e. before row closure, weed density per 1 m² was medium and it was 11.7 on the average, and before tuber harvest 11.5 individuals (Tabs 3, 4) represented by 20 and 18 species, respectively (Tabs 5, 6).

The number of weeds per 1 m² at both determination dates depended significantly on the weed control method (Tabs 3, 4). In the mechanically controlled treatments, both at the beginning and end of vegetation, weed density per 1 m² was the highest and floristically richest compared to the other weed control options.

Prior to the closure of potato rows, the lowest average weed density, compared to the control variant, was noted in treatment 4 (mechanical weed control until emergence, and right before emergence the mixture of herbicides Plateen 41.5 WG 1.6 kg × ha^{-1} + Fusilade Forte 150 EC 2.0 dm^3 × ha^{-1} + adjuvant Atpolan 80 EC 1.5 dm^3 × ha^{-1}), and it was 8.1 pcs. per 1 m², as well as in treatment 3 (mechanical weed control and the herbicides Plateen 41.5 WG 2.0 kg × ha^{-1} + Fusilade Forte 150 EC 2.5 dm^3 × ha^{-1}) – 9.3 pcs. per 1 m². The number of weeds in these treatments was more than

Table 5
The species composition and number of weeds per 1 m^2 before potato row closure in the study years.

Species	Years			Mean	Percentage of species
	2002	2003	2004		
Fallopia convolvulus (L.)	0.6	1.8	0.6	1.0	8.5
Veronica arvensis (L.)	2.0	–	1.7	1.2	10.3
Capsella bursa–pastoris	0.3	–	2.7	1.0	8.5
Chenopodium album (L.)	0.7	1.1	0.6	0.8	6.8
Lamium purpureum (L.)	0.3	2.1	–	0.8	6.8
Sinapis arvensis (L.)	1.2	0.2	–	0.5	4.3
Polygonum persicaria (L.)	0.2	–	1.7	0.6	5.1
Galium aparine (L.)	0.6	0.3	–	0.3	2.6
Viola arvensis Murray	0.3	0.9	–	0.4	3.4
Plantago lanceolata (L.)	–	–	1.2	0.4	3.4
Convolvulus arvensis (L.)	0.9	–	0.3	0.4	3.4
Galinsoga parviflora Cav.	–	0.2	0.4	0.2	1.7
Stellaria media (L.)	–	0.3	0.4	0.2	1.7
Amaranthus retroflexus (L.)	0.1	0.3	–	0.1	0.9
Other dicotyledonous species 2002–2004 (3)*	0.8	2.0	0.3	1.2	10.3
Total dicotyledonous	8.0	9.2	10.4	9.1	77.7
Elymus repens (L.)	0.6	1.4	3.4	1.8	15.4
Echinochloa crus–galli (L.)	0.3	–	0.6	0.3	2.6
Poa annua (L.)	–	–	1.3	0.5	4.3
Total monocotyledonous	0.9	1.4	5.3	2.6	22.3
Total dicotyledonous and monocotyledonous	8.9	10.6	15.7	11.7	–
Total number of species	13.0	13.0	12.0	–	–

**Urtica urens* (L.), *Thlaspi arvense* (L.), *Chamomilla suaveolens* (Pursh)

twice lower compared to the control plots. In all the mechanically and chemically controlled treatments, the number of taxa was significantly lower compared to the control treatment.

Also before the harvest of potato tubers, the most effective weed reduction methods were variants 4 and 3 (Tab. 4). The chemical weed killers applied in treatment 4 lowered more than twice the number of weeds compared to the control treatment, and the weed infestation level was low. The other herbicides and their mixtures also reduced significantly both dicotyledonous and monocotyledonous species. Monocotyledonous weeds were reduced most effectively by the herbicide mixture containing Fusilade Forte 150 EC (treatments 3, 4 and 6, 7).

The weather factor significantly affected the number of weeds at both dates (Tabs 5, 6). Weed infestation of potato in the years 2002 and 2003 was at a similar level and it was significantly lower than in the 2004 growing season. Favourable moisture and thermal conditions for the development of segetal vegetation prevailed in the summer months of 2004. The weed species composition also varied in particular growing seasons. The lowest number of species was noted in 2004.

The analysis of variance showed an interaction in the number of weeds determined at the beginning of vegetation between weed control methods and study years, which demonstrates the dependence of the effect of herbicides on air temperature and rainfall amounts during the growth of potato plants (Tab. 7). The lowest number of weeds was found in 2002 in the treatments sprayed with the mixture of herbicides Plateen 41.5 WG and Fusilade Forte 150 EC (treatment 3) and with the same mixture with an addition of the adjuvant (treatment 4). Under the conditions in the year 2003, which was characterised by a severe dry spell, the lowest number of weeds was recorded after the application of the mixtures of herbicides Barox 460 SL and Fusilade Forte 150 EC. But before tuber harvest, no significant interaction was found between weed control methods and study years.

Table 6
The species composition and number of weeds per 1 m² before potato tuber harvest in the study years.

Species	Years			Mean	Percentage of species
	2002	2003	2004		
Fallopia convolvulus (L.)	0.5	1.9	0.5	1.0	8.7
Veronica arvensis (L.)	0.8	–	0.1	0.3	2.6
Capsella bursa–pastoris	–	0.2	0.2	0.1	0.9
Chenopodium album (L.)	1.2	1.8	1.0	1.3	11.3
Lamium purpureum (L.)	–	2.3	–	0.8	7.0
Sinapis arvensis (L.)	0.4	–	–	0.1	0.9
Polygonum persicaria (L.)	0.1	0.4	0.1	0.2	1.7
Galium aparine (L.)	0.1	–	–	–	–
Viola arvensis Murray	0.8	0.3	0.1	0.4	3.4
Plantago lanceolata (L.)	–	–	2.8	1.0	8.7
Convolvulus arvensis (L.)	1.0	–	–	0.3	2.6
Galinsoga parviflora Cav.	–	0.1	–	–	–
Stellaria media (L.)	0.4	0.2	4.2	1.6	13.9
Amaranthus retroflexus (L.)	0.2	0.4	–	0.2	1.7
Other dicotyledonous species 2002–2004 (3)*	1.5	1.4	0.3	1.1	9.6
Total dicotyledonous	7.0	9.0	9.3	8.4	73.0
Elymus repens (L.)	0.7	1.6	3.3	1.9	16.5
Echinochloa crus–galli (L.)	0.3	0.3	0.9	0.5	4.4
Poa annua (L.)	–	–	2.1	0.7	6.1
Total monocotyledonous	1.0	1.9	6.3	3.1	27.0
Total dicotyledonous and monocotyledonous	8.0	10.9	15.6	11.5	–
Total number of species	14.0	14.0	12.0	–	–

**Urtica urens* (L.), *Thlaspi arvense* (L.), *Chamomilla suaveolens* (Pursh)

Table 7
The number of weeds per 1 m² depending on weed control methods and study years.

Weed control methods	Years			Mean	Years			Mean
	2002	2003	2004		2002	2003	2004	
	Before row closure				Before tuber harvest			
1*	16.4	22.5	26.2	21.7	12.0	18.5	23.5	18.0
2	3.8	12.0	14.1	10.0	8.4	10.4	16.0	11.6
3	3.0	11.5	13.5	9.3	6.2	9.0	14.2	9.8
4	3.0	11.2	10.2	8.1	5.0	8.7	10.0	8.0
5	13.2	6.4	18.0	12.5	8.8	10.7	16.1	11.9
6	12.4	4.7	16.1	11.1	8.0	10.0	16.1	11.4
7	10.5	5.9	11.9	9.4	7.7	9.3	13.6	10.2
Mean	8.9	10.6	15.7	11.7	8.0	10.9	15.6	11.5
$LSD_{0.05}$ between: weed control methods				3.8	$LSD_{0.05}$ between: weed control methods			2.9
years				3.5	years			3.3
in interaction weed control methods x years				6.6	in interaction weed control methods x years			r.n

* weed control methods as in research methodology

DISCUSSION

The present study showed that the number of weeds at both determination dates was significantly dependent on the tillage system, weed control method and atmospheric conditions prevailing in the study years. Lower weed infestation occurred in the treatments with traditional tillage than after the application of reduced tillage. These results are in agreement with the observations of Kraska and Pałys (2002); in their opinion, the number of weeds and weed species composition before row closure and before tuber harvest were higher in the reduced tillage system than under plough tillage. In the opinion of Bujak and Frant (2006), the application of simplifications in the set of post-harvest treatments only slightly increased the occurrence of segetal vegetation in the potato canopy.

Potato plants were accompanied by weeds typical for this crop plant, and the following were predominant: *Elymus repens* (L), *Fallopia convolvulus* (L.), *Capsella bursa-pastoris* (L.), *Chenopodium album* (L.), which is confirmed by studies of other authors (Bujak and Frant, 2006; Kraska and Pałys, 2002; Pszczółkowski, 2003; Zarzecka and Gugała, 2005).

The herbicides applied in potato treatments evidently resulted in quantitative and qualitative changes in the weed population. At both determination dates, the plots in which only mechanical weed control had been used were most weed-infected, and the lowest weed infestation was on the mechanically and chemically controlled plots with the application of herbicide mixtures. Similar research results were obtained by Gruczek (2002), Pałys (1994), Rymaszewski et al. (1996), Zarzecka et al. (2002).

In the authors' study, it was observed that the number of weeds and weed species composition per area unit were the highest in the wettest year 2004. These results are in agreement with the observations of Szymankiewicz et al. (2002) and Rola (2002). In the opinion of Urbanowicz (2000), Pawińska (2002), the effects of herbicide application depend on soil moisture and the weed spectrum.

The obtained results of the study convince that it is justified to apply mechanical and chemical weed control methods in potato growing, and in the opinion of Mierzejewska (1992), the significance of plant protection increases along with an increase in yields.

CONCLUSIONS

1. The number of weeds at both determination dates was significantly dependent on the soil tillage system. Lower weed infestation occurred in the treatments with traditional tillage than after the application of reduced tillage.
2. The herbicides applied in weed control in potato crops produced a significant reduction in weed infestation compared to only mechanical treatments. The lowest weed infestation level occurred when mechanical weed control was performed after planting and right before emergence the mixture of herbicides Plateen 41.5 WG + Fusilade Forte 150 EC was applied at a recommended dose and at a dose reduced by 20%.
3. In the present study, weed species belonging to the dicotyledonous class were predominant over monocotyledonous weeds. Both at the beginning of vegetation and before tuber harvest, the dominant species was *Elymus repens* (L.). At both determination dates, the number of weeds per 1 m^2 varied, whereas the number of species was similar.
4. The weather factor significantly modified weed infestation of potato canopies, which was at a similar level in the years 2002 and 2003, whereas it was significantly lower in the 2004 growing season.

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Wpływ sposobu uprawy roli i pielęgnacji na zachwaszczenie ziemniaka

S t r e s z c z e n i e

Doświadczenie polowe przeprowadzono w latach 2002-2004 w Rolniczej Stacji Doświadczalnej Zawady (52º06' N; 22º06' E), należącej do Akademii Podlaskiej w Siedlcach. Badanymi czynnikami były dwa sposoby uprawy roli (tradycyjna i uproszczona) i siedem sposobów odchwaszczania łanów ziemniaka z użyciem herbicydów. Celem badań było określenie wpływu sposobów uprawy roli i pielęgnacji na skład gatunkowy i liczebność chwastów. Zachwaszczenie łanów ziemniaka na początku wegetacji, jak również przed zbiorem bulw istotnie różnicowały sposoby uprawy, sposoby pielęgnacji oraz warunki atmosferyczne występujące w latach badań. Najmniejszą liczbę chwastów w porównaniu z obiektem kontrolnym zanotowano na obiektach odchwaszczanych mechaniczno-chemicznie. Również mniejsze zachwaszczenie wystąpiło na obiektach z uprawą tradycyjną niż po zastosowaniu uproszczeń.